COLUMBIA

ACCIDENT INVESTIGATION BOARD

Note: Volumes II – VI contain a number of conclusions and recommendations, several of which were adopted by the Board in Volume I. The other conclusions and recommendations drawn in Volumes II – VI do not necessarily reflect the opinion of the Board, but are included for the record. When there is conflict, Volume I takes precedence.

REPORT VOLUME V

APPENDICES G.1 – G.9

OCTOBER 2003

On the Front Cover

This was the crew patch for STS-107. The central element of the patch was the microgravity symbol, µg, flowing into the rays of the Astronaut symbol. The orbital inclination was portrayed by the 39-degree angle of the Earth's horizon to the Astronaut symbol. The sunrise was representative of the numerous science experiments that were the dawn of a new era for continued microgravity research on the International Space Station and beyond. The breadth of science conducted on this mission had widespread benefits to life on Earth and the continued exploration of space, illustrated by the Earth and stars. The constellation Columba (the dove) was chosen to symbolize peace on Earth and the Space Shuttle Columbia. In addition, the seven stars represent the STS-107 crew members, as well as honoring the original Mercury 7 astronauts who paved the way to make research in space possible. The Israeli flag represented the first person from that country to fly on the Space Shuttle.

On the Back Cover

This emblem memorializes the three U.S. human space flight accidents – Apollo 1, Challenger, and Columbia. The words across the top translate to: "To The Stars, Despite Adversity – Always Explore"

The Board would like to acknowledge the hard work and effort of the following individuals in the production of Volumes II – VI.

Maj. Gen. John L. Barry	Executive Director to the Chairman
Dennis R. Jenkins	Investigator and Liaison to the Board
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VOLUME I

VOLUME II

CAIB TECHNICAL DOCUMENTS CITED IN THE REPORT

Reader's Guide to Volume V

Volume V of the Report contains appendices that were not cited in Volume I. These consist of documents produced by NASA and other organizations, which were provided to the Columbia Accident Investigation Board in support of its inquiry into the February 1, 2003 destruction of the Space Shuttle *Columbia*. The documents are compiled in this volume in the interest of establishing a complete record, but they do not necessarily represent the views of the Board. Volume I contains the Board's findings, analysis, and recommendations. The documents in Volume V are also contained in their original color format on the DVD disc in the back of Volume II.

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Volume V
Appendix G.1

Requirements and Procedures for Certification of Flight Readiness

This Appendix contains NASA NSTS 08117 Revision L, December 13, 1995 document Space Shuttle, Requirements and Procedures for Certification of Flight Readiness.

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National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NSTS 08117
REVISION L
DECEMBER 13, 1995

SPACE SHUTTLE

REQUIREMENTS AND PROCEDURES FOR CERTIFICATION OF FLIGHT READINESS

FOREWORD

Efficient management of the Space Shuttle Program (SSP) dictates that effective control of program activities be established. Requirements, directives, procedures, interface agreements, and system capabilities shall be documented, baselined, and subsequently controlled by SSP management.

Program requirements controlled by the Manager, Space Shuttle Program, are documented in, attached to, or referenced from Volumes I through XVIII of NSTS 07700. NSTS 08117, Requirements and Procedures for Certification of Flight Readiness Requirements, establishes a standard approach to be used jointly by contractors and NASA to incrementally review flight preparation of the Space Shuttle Vehicle (SSV). The requirements and procedures herein provide a means for assuring a uniform flight readiness assessment of all SSV elements.

All elements of the SSP must adhere to these baselined requirements. When it is considered by the Space Shuttle Program/Project Managers to be in the best interest of the SSP to change, waive, or deviate from these requirements, an SSP Change Request (CR) shall be submitted to the Program Requirements Control Board (PRCB) Secretary. The CR must include a complete description of the change, waiver, or deviation and the rationale to justify its consideration. All such requests will be processed in accordance with NSTS 07700, Volume IV, and dispositioned by the Manager, Space Shuttle Program, on a Space Shuttle PRCB Directive (PRCBD).

Loren J. Shriver
Manager, Launch Integration, KSC

CONTENTS

NSTS 08117

CONTENTS

NSTS 08117

APPENDICES

NSTS 08117

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to define the Space Shuttle Program (SSP) Flight Preparation Process (FPP). It defines the procedures for the Project Milestone Reviews, the Program Milestone Reviews and the Flight Readiness Review (FRR). It also defines the endorsement documentation required at the completion of the FRR which provides the Certification of Flight Readiness (CoFR) for a specific flight.

1.2 SCOPE

This document is applicable to JSC, KSC, MSFC, Stennis Space Center (SSC), and SSP NASA and contractor organizations and personnel involved in the conduct of Space Shuttle operations. The FPP consists of the required preparations for a Space Shuttle mission, from the baselining of the processing requirements to acceptance of the major hardware elements through processing, mating, launch, and ferry when required. The major elements of the FPP are the Project Milestone Reviews, three Program Milestone Reviews, and the FRR where the CoFR endorsement is signed. Reviews of the activities that support the FPP are considered part of the CoFR process.

This Revision L identifies the processes and requirements for all milestone reviews and the FRR for STS–78 and subsequent flights. Revision K applies to prior flights.

1.3 PROCESS DESCRIPTION

The FPP is structured to baseline a set of processing requirements through a series of requirements reviews and to incrementally review and status progress towards readiness for flight (reference Figure 1). It represents a commitment by each of the SSP element and project managers (NASA and contractor) certifying that their organizations have satisfactorily completed the requirements and their respective portions of the effort required to safely support each flight. The FPP is incrementally implemented through milestone reviews and an FRR which ensures the readiness of all organizations for the operational phase following each review. The FPP consists of Project Milestone Reviews, three Program Milestone Reviews and the FRR. The Project Milestone Reviews are the DD 250/1149–Element Acceptance Reviews, the Payload Readiness Review (PRR), the Software Readiness Review (SRR), and the organizational Pre–FRR Reviews. The three Program Milestone Reviews are the Pre–Mate Milestone Reviews, consisting of the External Tank (ET)/Solid Rocket Booster (SRB) Mate Milestone Review and the Orbiter Rollout/ET Mate Milestone Review, and a Ferry Flight Readiness Milestone Review which is conducted when a ferry is required. The CoFR endorsement is signed at the FRR. A Prelaunch Mission Management Team (PMMT) Review will be conducted on the Launch Minus Two (L–2) Day or Launch

Minus One (L–1) Day when the Mission Management Team (MMT) is activated to status the launch countdown and address any issues remaining from the FRR (reference Figure 2). (Reference NSTS 07700 Volume III, Flight Definition and Requirements Directive; NSTS 07700, Volume IV, Configuration Management Requirements; and NSTS 07700, Volume VIII, Operations, Appendix D.)

1.4 RESPONSIBILITIES

The Manager, Launch Integration shall manage the FPP. SSP organizations and their respective contractors are responsible for implementing the FPPs as outlined in the appendices of this document. The implementation will be done by certifying that the required work under their purview, as defined in the Flight Preparation Process Plans (FPPPs) for each certifying organization, has been satisfactorily completed and will safely support the specified flight.

The review secretariat function for Program Milestone Reviews and the FRR shall be the responsibility of the Space Flight Operations Contract (SFOC) Program Integration Office at KSC. The secretariat function for the Project Milestone Reviews, shall be the responsibility of the review Chair.

FIGURE 1

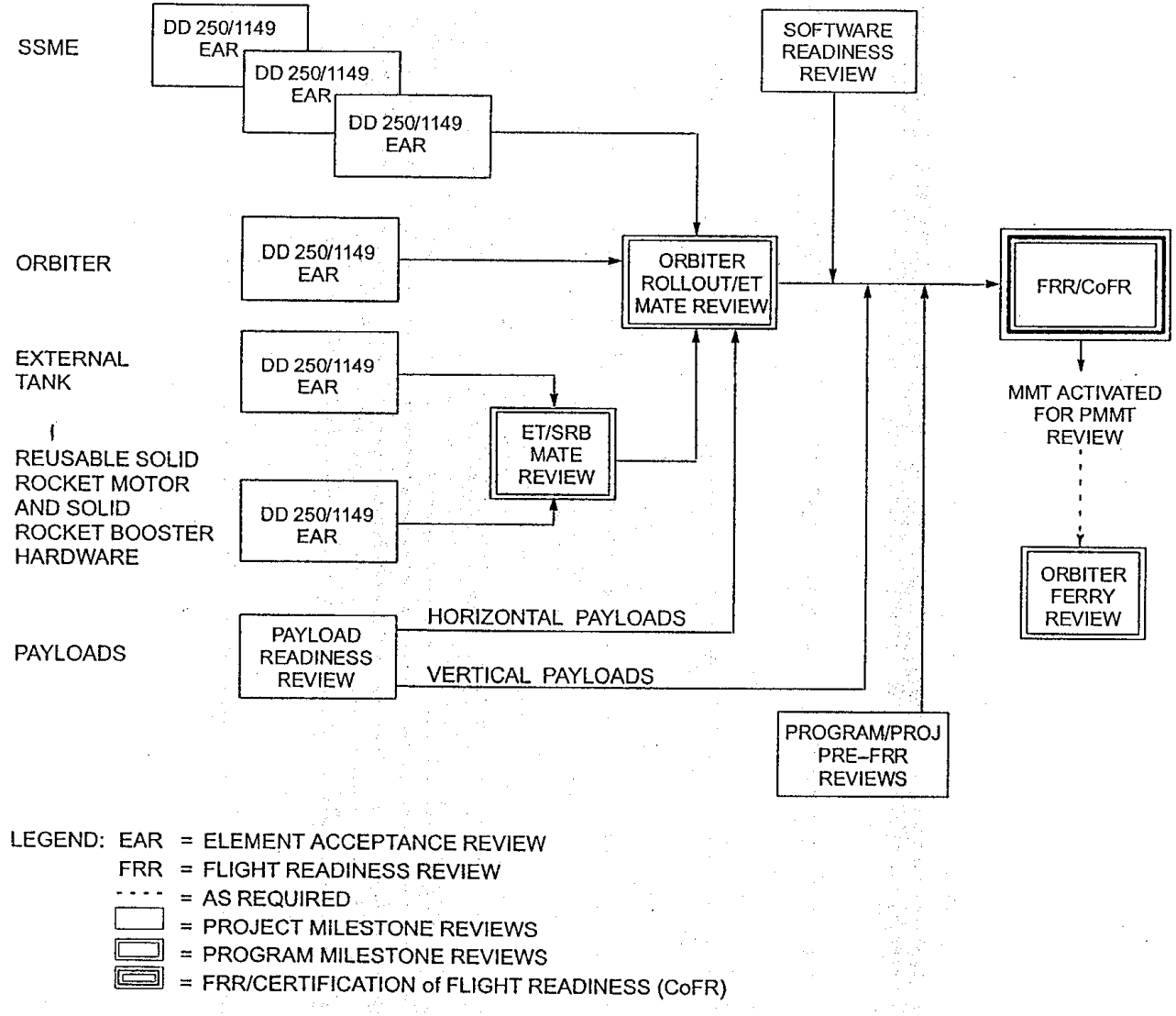
FLIGHT PREPARATION PROCESS

*NOTE: See Figure 2 for expansion.

NOTE: For specific timeline information, see JSC 25187, Flight Production Generic Template, Appendix A.

FIGURE 2

MILESTONE REVIEWS PROCESS



8.0 FLIGHT READINESS REVIEW (FRR)

Approximately two weeks prior to launch, a FRR will be conducted that will determine the readiness of the SSV, flight crew, and payloads. At the review, organizations identified in Paragraph 8.7b will certify the completion of all tasks and planned work required to prepare the flight/ground hardware/software, support facilities, and operations personnel to safely support a specific mission. Readiness for flight shall be determined through the review of necessary data to ensure satisfactory closeout of all FRR certification requirements, exceptions, and launch constraints, and be in sufficient detail to provide the Associate Administrator (AA), Office of Space Flight with the information needed to make a decision as to flight readiness.

8.1 POLICY

The FRR is an integrated senior management review chaired by the AA, Office of Space Flight who is supported by a review board. It is the policy of the AA, Office of Space Flight to make an assessment of mission readiness prior to each flight. This will be accomplished by a comprehensive review of all activities/elements necessary for the safe and successful conduct of all operations from prelaunch through post–landing and recovery operations. Government and contractor representatives will certify readiness in their areas of responsibility.

8.2 CERTIFICATION REQUIREMENTS

The CoFR endorsement certifies all organizations (NASA and contractor) have successfully completed their FPPs and products per their Flight Preparation Process Plans (FPPPs). During the transition period for the SFOC contract the transition plans and PDPs document the transfer of responsibilities from NASA to the contractor and should be referenced for complete CoFR accountability.

8.2.1 Flight Preparation Process Plans

Each organization's FPPP defines the processes and products the organization will complete for a each mission. The FPPP ensures the successful assembly, launch and completion of the flight. As applicable for each organization, the process plans shall encompass all major and critical operations, design, certification, analyses, testing, documentation, and requirements definition required for the each mission. The major processes involved are as follows:

a. Vehicle processing

b. Payload processing

c. Configuration management/requirements definition

d. Flight certification (including Launch Commit Criteria [LCC], flight rules, etc.)

e. Facility/equipment/GSE certification

f. Personnel certification

g. Special testing/analyses

h. Material review

i. Hazard analyses

j. Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL)

k. Crew training/medical certification

l. Validation that external inputs are appropriate for this specific flight

In addition, the following products and processes which organizations participate in, but are not their unique responsibilities, shall be completed in support to external organizations:

a. Develop/validate/deliver products requested by external organizations

b. Delivery of hardware or software and support data

c. Operations and Maintenance Requirements and Specifications Document (OMRSD)/LCC requirements definition

d. Configuration drawings

e. Anomaly/discrepancy resolution

f. Flight rules requirements

g. Crew procedures requirements

h. Flight design definition

i. Flight constraints definition

j. Ferry requirements

k. Time, cycle, age life, interval inspection, and maintenance requirements

l. Flight Data File (FDF) requirements

8.3 FLIGHT READINESS REVIEW PREPARATION

Each organization shall be responsible for conducting a Pre–FRR in preparation for the SSP FRR which ensures their project FPPPs are satisfied. The program/projects shall

FIGURE 3
CoFR ENDORSEMENT

STS–____ CoFR ENDORSEMENT

ELEMENT	SERIAL NUMBER		PAYLOAD
ORBITER			
ET			
RSRM			
SSME			
SRB			

Projects having exceptions to this CoFR document are as follows (see Exception Log for details):

SSP Form 4042 (Rev Sep 02) Page 1 of 7

FIGURE 3
CoFR ENDORSEMENT – Continued

STS–____ CoFR ENDORSEMENT

The Flight Preparation Process Plans documented in NSTS 08117, Requirements and Procedures for Certification of Flight Readiness, have been satisfied. Required products and other responsibilities for each project (NSTS 08117, Section 8) have been or will be produced or completed.

a. Certified flight hardware elements have been delivered to the SFOC at the Kennedy Space Center.

b. Required hardware element processing specifications and requirements have been delivered to the SFOC.

c. All identified "out-of-family" events that occurred after delivery of hardware for launch processing/ assembly/testing have been resolved.

d. For "out-of-family" conditions detected during manufacturing, testing, or post-mission tear down and analysis, notification to the Space Shuttle Program has been made, and corrective action, if any, identified.

e. The as-built flight element configuration satisfies the released requirements and engineering, based on data compiled and reviewed by SFOC.

f. For the Space Shuttle Main Engine Project: Certified main engine controller software has been delivered for this mission.

CONTRACTOR			NASA	
SSME (8.5.3.1, 8.5.3.2, Apx. C)	PROGRAM MANAGER, ROCKETDYNE	DATE	MANAGER, SSME PROJECT, MSFC	DATE
ET (8.5.4.1, 8.5.4.2, Apx. D)	PROGRAM MANAGER, LMMSS	DATE	MANAGER, ET PROJECT, MSFC	DATE
RSRM (8.5.5.1, 8.5.5.2, Apx. E)	PROGRAM MANAGER, THIOKOL	DATE	MANAGER, RSRM PROJECT, MSFC	DATE
CONCURRENCE				
MSFC SHUTTLE PROJECTS	N/A		MANAGER, MSFC SHUTTLE PROJECTS	DATE

SSP Form 4042 (Rev Sep 02) Page 2 of 7

FIGURE 3
CoFR ENDORSEMENT – Continued

STS–____ CoFR ENDORSEMENT

The Flight Preparation Process Plans documented in NSTS 08117, Requirements and Procedures for Certification of Flight Readiness, have been satisfied. Required products and other responsibilities for each organization (NSTS 08117, Section 8) have been or will be produced or completed.

a. For Payload Processing: Flight and ground requirements, payload logistics, and configuration requirements provided by the flight projects, have been maintained, performed, or are planned to be performed per approved TOPs.

b. For EVA project: Audit, insight, and surveillance of SFOC activities have been completed or are planned for completion, and all discrepancies have been resolved. Oversight functions have been conducted in conjunction with Hamilton Sundstrand.

NASA

FLIGHT CREW OPERATIONS (8.5.11.1, 8.5.11.2, Apx. K)	DIRECTOR, FLIGHT CREW OPERATIONS	DATE
FERRY OPERATIONS (8.5.16.1, 8.5.16.2, Apx. P)	FERRY OPERATIONS MANAGER	DATE
SPACE AND LIFE SCIENCES (8.5.15.1, 8.5.15.2, Apx. O)	DIRECTOR, SPACE AND LIFE SCIENCES	DATE
SPACE SHUTTLE SR&QA (8.5.17.1, 8.5.17.2, Apx. Q)	MANAGER, SPACE SHUTTLE SR&QA	DATE

	CONTRACTOR		NASA	
PAYLOAD PROCESSING (8.5.10.1, 8.5.10.2, Apx. J)	PROGRAM MANAGER, CAPPS BOEING, KSC	DATE	DIRECTOR OF ISS/PAYLOAD PROCESSING	DATE
EVA (8.5.2.1, 8.5.2.2, Apx. B)	PROGRAM MANAGER, HAMILTON SUNDSTRAND	DATE	MANAGER, EVA PROJECT OFFICE	DATE

SSP Form 4042 (Rev Oct 02) Page 3 of 7

FIGURE 3
CoFR ENDORSEMENT – Continued

STS– ____ CoFR ENDORSEMENT

The Flight Preparation Process Plans documented in NSTS 08117, Requirements and Procedures for Certification of Flight Readiness, have been satisfied. Required products and other responsibilities (shared or independent) for each organization (NSTS 08117, Section 8) have been or will be produced or completed.

a. The following NASA organizations have completed or plan to complete audit, insight, and surveillance of contractor activities, and have resolved all discrepancies.

NASA

CUSTOMER AND FLIGHT INTEGRATION (8.5.14.1, 8.5.14.2, Apx. N)	MANAGER, SPACE SHUTTLE CUSTOMER AND FLIGHT INTEGRATION	DATE
KSC INTEGRATION (8.5.12.1, 8.5.12.2, Apx. L)	MANAGER, SPACE SHUTTLE KSC INTEGRATION	DATE
SHUTTLE PROCESSING (8.5.8.1, 8.5.8.2, Apx. H)	DIRECTOR OF SHUTTLE PROCESSING, KSC	DATE
MISSION OPERATIONS (8.5.7.1, 8.5.7.2, Apx. G)	DIRECTOR, MISSION OPERATIONS	DATE
SRB (8.5.6.1, 8.5.6.2, Apx. F)	MANAGER, SRB PROJECT, MSFC	DATE
SSP S&MA	MANAGER, SSP S&MA	DATE
SYSTEMS INTEGRATION (8.5.13.1, 8.5.13.2, Apx. M)	MANAGER, SPACE SHUTTLE SYSTEMS INTEGRATION	DATE
VEHICLE ENGINEERING (8.5.1.1, 8.5.1.2, Apx. A)	MANAGER, SPACE SHUTTLE VEHICLE ENGINEERING	DATE

SSP Form 4042 (Rev Sep 02) Page 4 of 7

FIGURE 3
CoFR ENDORSEMENT – Continued

STS–____ CoFR ENDORSEMENT

The Space Shuttle Flight Preparation Process Plans (shared or independent) documented in NSTS 08117, Requirements and Procedures for Certification of Flight Readiness, have been satisfied. Required products and other responsibilities (shared or independent) for the SFOC (NSTS 08117, Section 8) have been or will be produced or completed.

a. All out-of-family conditions have been identified and resolved with the NASA.

b. The SSV has been processed in accordance with requirements and policies baselined by the SSP.

UNITED SPACE ALLIANCE

SFOC SQ&MA CONCURRENCE	VICE PRESIDENT, SAFETY, QUALITY AND MISSION ASSURANCE, SFOC	DATE
SFOC (8.5.18.1, 8.5.18.2, Apx. R)	SSP, PROGRAM MANAGER, SFOC	DATE

Boeing endorses that the requirements for CoFR documented in SSP 50108 and the Boeing Flight CoFR Implementation Plan have been satisfied in accordance with the Boeing specific responsibilities for this flight. Any issues that have arisen since the Stage Operations Readiness Review (SORR) have been resolved or have been presented at the Flight Readiness Review. This certification is subject to clause H.43 of NAS 15-10000 (for ISS Missions).

BOEING

ISS PRIME CONCURRENCE	VICE PRESIDENT AND PROGRAM MANAGER, ISS, BOEING	DATE

SSP Form 4042 (Rev Oct 02) Page 5 of 7

NSTS 08117
Revision L

8–35

CHANGE NO. 71

FIGURE 3
CoFR ENDORSEMENT – Continued

STS– _____ CoFR ENDORSEMENT

NASA SSP READINESS

The preparation of all Space Shuttle Program and Project organizations for this mission has been reviewed. All required processes, products, and responsibilities are complete or will be completed prior to launch. Deviations, exceptions or waivers have been reviewed and will be dispositioned by the Prelaunch MMT Review for this mission. The Space Shuttle Program is ready to proceed with the conduct of this mission.

MANAGER, SPACE SHUTTLE PROGRAM INTEGRATION — DATE

MANAGER, LAUNCH INTEGRATION — DATE

MANAGER, SPACE SHUTTLE PROGRAM — DATE

NASA ISS PROGRAM READINESS

All necessary activities required to support the flight, stage and increment have been accomplished or are planned. All deviations, waivers, and exceptions have been reviewed and satisfactorily dispositioned. The International Space Station Program is ready to proceed with launch and on-orbit operations. Any issues that have arisen since the SORR have been resolved or have been presented at the Flight Readiness Review (for ISS Missions).

MANAGER, INTERNATIONAL SPACE STATION PROGRAM — DATE

CONCURRENCE

I concur that the Space Shuttle Program and the International Space Station Program (for ISS Missions) are ready to proceed with this mission.

DEPUTY ASSOCIATE ADMINISTRATOR FOR INTERNATIONAL SPACE STATION AND SPACE SHUTTLE PROGRAMS — DATE

SSP Form 4042 (Rev Oct 02) Page 6 of 7

FIGURE 3
CoFR ENDORSEMENT – Concluded

STS– ____ CoFR ENDORSEMENT

CONCURRENCE

As a member of the FRR Board, I concur that, pending completion of planned work, the Space Shuttle Program and International Space Station Program (for ISS Missions) are ready to execute this mission.

DIRECTOR, JOHNSON SPACE CENTER	DATE
DIRECTOR, KENNEDY SPACE CENTER	DATE
DIRECTOR, MARSHALL SPACE FLIGHT CENTER	DATE
DIRECTOR, STENNIS SPACE CENTER	DATE

As a member of the FRR Board, I concur that, pending completion of planned work, the Prime Mission is ready to execute this mission (for non-ISS missions).

ASSOCIATE ADMINISTRATOR FOR PRIME MISSION	DATE

NASA S&MA has reviewed the status of preparations for this mission and has performed an independent assessment of the readiness of the Space Shuttle Program for the conduct of this mission, and the readiness of the International Space Station for launch and on-orbit operations (for ISS missions). We are in concurrence with proceeding with this mission.

ASSOCIATE ADMINISTRATOR, SAFETY AND MISSION ASSURANCE	DATE

APPROVAL

The FRR Board has conducted a comprehensive assessment of the readiness of all flight and ground systems and supporting personnel. For ISS missions, the FRR Board has also conducted a comprehensive assessment of the readiness of the Launch Package/Cargo Element (LP/CE), ground hardware/software support facilities and personnel to support the flight, stage and increment including the readiness of the on-orbit stage to accept the LP/CE and return items. The Certificate of Flight Readiness has been endorsed by each program element. I have concluded, with the concurrence of the FRR Board, that pending completion of planned work, the Space Shuttle Program is ready to execute this mission and the International Space Station Program is ready for launch and on-orbit operations (for ISS missions).

ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE FLIGHT (CHAIR, FRR BOARD)	DATE

SSP Form 4042 (Rev Oct 02) Page 7 of 7

NSTS 08117
Revision L

8–36A

CHANGE NO. 71

B2-000089